ACASYS-KS

Communication in ACASYS system

Programmer manual

Version 1.07

AMiT

Producer: AMiT, spol. s r. o.
Naskové 3/1100, 150 00 Praha
www.amit.cz

Technical support: support@amit.cz

Contents

History of revisions

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Author: O. Stančík

Revision	Date	Changes
100	02. 08. 2012	New document
101	29. 10. 2012	Transmission ports are set to “Implementation independent” in accordance with actual implementation. Completion of information to the arrays with gps location for TxCU-RxRU
102	22. 11. 2012	Scenes configuration. Attachment of CAMS_MASK.
103	01. 12. 2012	Spelling check, document template update, editing of text in chapters 3.1 Example, 4.1 and 4.2 Backlight description, 5.1 GPS_xxx.
104	03. 07. 2013	Extension of TxRU-RxCU frame.
105	27. 09. 2013	Correction of TxIPM-RxCU frame length.
106	25. 11. 2013	Correction of TxCU-RxRU, TxIS-RxRU frame length.
107	11. 04. 2014	Detailed description of time synchronization (part TIME of TxCU-RxRU frame) was added. Paragraph in 4.2 about FSG_fields.

Related documentation

1. **ACASYS-KS** Modular camera system – Projection manual
   file: acasys-ks_mp_en_xxx.pdf
2. User manual – Acasys Studio – Browser for videorecords from **PPM2000** unit
   file: acasysstudio_ms_en_xxx.pdf

1. Introduction

This document describes the communication interface between Camera system **ACASYS-KS** and surrounding units.

The communication protocol is named TRUD.

Camera system consist of IP monitors, IP cameras as and recording unit.

IP monitors displays the video-stream from single or more cameras. The recording unit records image mostly from all cameras, with decreased fps (frames per second).

IP monitors or recording unit can absent in camera system.

2. Protocol specification

Basic characteristic

- Client/server type protocol, based on Ethernet v2 (RFC 1191) link layer and UDP (RFC768) transport layer.
- Multibyte data types are coded in little-endian format.
- Every TRUD frame is transported just by single UDP packet. Therefore, into single UDP packet can not be placed more TRUD frames, and concurrently splitting a single TRUD frame into several UDP packets is not supported (Notice: it does not apply to fragmentation on IP layer level).

Application profile

In the application profile are determined the elementary communication parameters. The application profile is described hereafter.

2.1. IP addresses and ports

- Device IP addresses can be part of application profile or they can be defined in other document.
- Assigning of ports is included in application profile.

2.2. Question/answer (Q/A) type communication

- The question is sent to server in so called 'question-frame' form.
- Based on content of corresponding inquiry the server sends the answer in so called 'answer-frame' form.
- Communication drop-out occurs when a timeout is detected while client is waiting for response. The timeout size is determined in application profile.

Exchange algorithm

The communication process is specified by sequence of exchanges of questions and responses in time period. The algorithm of single data exchange takes place in a different way for client and for server.

- From the client standpoint:
  1. Question-frame assembly.
  2. Sending of question-frame to the server.
  3. During timeout waiting for server answer to the sent frame.
  4. When the server's answer to the sent frame came before timeout elapsed, client can process the answer content. Otherwise an UDP drop-out occurred and transmission is to be repeated.

- From the server standpoint:
  1. Waiting for client's question-frame.
  2. Assembly of answer-frame depending on contents of question.
  3. Sending the answer-frame to client.

2.3. "Parcel" type communication

One station sends to the second a frame with relevant data, without acknowledgment request. The transmitting station supposes that other party will receive data. The communication can go also in the opposite direction, so both

stations can mutually check their operation (but except for delivery of particular mail/“parcel“). This method of communication is intended for periodic data transfer.

2.4. Communication type selection

To communicate with particular node must be determined certain communication type, which can not be changed at runtime.
Q/A is designed for communication when changing values, the Parcel communication is designed for periodic data transfer.
In both cases is used the same header, only its meaning is changed.

2.5. Frame structure

Frame structure

Each TRUD frame consists of header and payload, structure and content of which (it can be also completely omitted) depends on application. But the header structure is firmly determined.
The header length is 8 bytes, the maximum permitted payload length is set to 1446 bytes. Together with headers of individual MAC, IP and UDP layers the total capacity 1500 bytes of Ethernet V2 frame is used.

Item	Type	Q/A	P
FLG	U16	Frame type	Frame type
	bit#0	1	0
	bit#1	1 – Question 0 – Answer	Meaningless
	bit#2 to 15	Meaningless	Meaningless
LEN	U16	Payload length in bytes	Payload length in bytes
ID	U16	Question type identifier	Frame type identifier
SEQ	U16	Exchange identifier	Meaningless
PLD	-	*Payload (structure depends on type of question)*	

Flags

The FLG item represents an area for specification of 16 different flag types. The zero-bit with value equal to 1 states the Q/A type of communication and the reverse value the P communication. Bit 1 indicates question or answer and used primarily for service/ debugging purpose. When using the Q/A type communication the stations are obliged to fit this bit properly.
Remaining bits are meaningless and their value is supposed to be zero.

Identification

The ID field specifies the type of question/ frame, i.e. meaning of frame or content of payload part PLD.

SEQ meaning

The role of SEQ item is to differentiate between the individual data exchanges. The client should set this item to a value, that he would be able to identify the relevant answer accordingly (in fact, the SEQ frame with relevant answer will include its copy). Using this mechanism the undesirable effects are eliminated, that could occur due to commutation of UDP packets order during data exchange, or by receiving of answers, client's timeout of which elapsed meanwhile.

Generating SEQ

System of generating of SEQ values in questions is an issue of the client, the only task for server is to copy these values into relevant answers. For this purpose can be used for example a random number generator with even distribution or some form of packet content check sum combined with question sequence repetition. The algorithm, which is the simplest and recommended as well is the ordinary counter of exchanges.

When using the Parcel-type communication, the SEQ field is ignored.

Payload

The structure of question frame payload PLD is determined by ID value. Then, the LEN item states the payload length in bytes. Its value must be within the interval from 0 to 1446.

Data types

In description of protocol are used names of data types with meaning as follows.

Label	Type	Length (bits)
U8/I8	Integer without/with sign	8
U16/I16	Integer without/with sign	16
U32/I32	Integer without/with sign	32
F32	Float	32
CSTR	Character string with variable length terminated with binary zero	

Data types are coded in little-endian format.

The string-extension of basic data types used hereinafter is designated as type[n] expression, where ‚type' states the basic string type and ‚n' its length (the ‚n' is a natural number greater than 0).

The character encoding type (ASCII, UTF-8, Unicode, …) is an integral part of application profile.

3. TRUD KS

This document describes the communication between Central Unit and IP monitors, as well as communication between Central Unit and Recording Unit.

Abbreviations used:

CU Central Unit

IPM IP monitor

RU Recording Unit

IS Information System

3.1. IP monitor operation principle

IP monitor displays the video-stream from single or more IP cameras. Images from more cameras are displayed on monitor in tile-windows arrangement with maximum number 4 × 4 (multi-view).
Viewing of particular camera or cameras must be firmly pre-defined. This is called ‘scene'. Then, through protocol, the CU sends an information to IPM, which scene is to be active at this moment.
Scenes configuration as well as another monitor features are defined in text file, which is loaded at once with FTP or SSH protocol into monitor. To create or modify the configuration file you can use the ACASYS Configurator as service software.

Example Let us have one IPM and two cameras on the left and right side. We want to display the left and right camera separately on the screen and then both cameras together. IP address of left camera is 192.168.1.1 and IP address of right camera is 192.168.1.2.

Below is a segment of configuration file, that contains definition of streams with accordance to example stated above:

```
stream=1;axis;192.168.1.1;0;Left;left camera
stream=2;axis;192.168.1.2;0;Right;right camera
stream=3;multi2x1;1,2;0;both the left and right camera in a single row
```

To display the left camera on IPM the central unit sends the frame TxCU-RxIPM (see the 4.1 chapter) with value of SCENE parameter adjusted to 1. Then, value of SCENE parameter equal to 2 is used when displaying the right camera and value 3 when displaying both cameras.

4. CU-IPM application profile

Communication type	PARCEL
Transmission period from CU	Depends on implementation
Transmission period from IPM	1 s
CU receive port	55000
CU transmission port	Depends on implementation
IPM receive port	55000
IPM transmission port	Depends on implementation

4.1. TxCU-RxIPM Frame

This frame is transmitted by CU and received by IPM.

Ofs	Item	Type	Value	Meaning
0	FLG	U16	0x0000	Frame type
2	LEN	U16	6	Payload length in bytes
4	ID	U16	0x0701	RxIPM-TxCU frame type identifier
6	SEQ	U16		Ignored.
8	LIFETIME	U8	0 to 255	Incrementing counter, indication of CU activity.
9	SCENE	U8		Scene which is to be displayed on IPM.
10	BACKLIGHT	U8	0 to 100	Adjustment of backlight intensity (percentual, with 10 % step).
11	CAMDIAG	U8	0	Do not perform diagnostics of connected cameras.
			1	Perform diagnostics of connected cameras.
12	RX_TM	U16		Timeout for receiving RxIPM frame [s] .

RX_TM Timeout for reception of RxIPM frame from CU to IPM. After restart the IPM sets the internal counter to 0. This internal variable is set by RX_TM. When not equal to zero, then, provided that no other RPM frames are received, the IPM sets the default scene (if defined).

CAMDIAG If this value equals to 1, IPM performs the diagnostics of connected cameras (ping), and diagnostic data are sent in TxIPM frame.
The CU is responsible for selection of only single IPM from given set which will perform this diagnostics.

4.2. TxIPM-RxCU Frame

This frame is transmitted by IPM and received by CU.

Ofs	Item	Type	Value	Meaning
0	FLG	U16	0x0000	Frame type
2	LEN	U16	36	Payload length in bytes
4	ID	U16	0x0700	TxIPM-RxCU frame type identifier
6	SEQ	U16		Ignored.
8	LIFETIME	U8	0 to 255	Incrementing counter, sign of IPM activity.
9	SCENE	U8		Scene which is actually displayed on IPM.

10	BACKLIGHT	U8	0 to 100	Currently adjusted intensity of backlight (percentual value).
11	ERROR	U8		Unit error code
			0	Without failure
			1	Unit's internal temperature exceeded
			2	Unit internal error.
12	CAMDIAG	U8		Copy of CAMDIAG field from TxCU-RxIPM frame:
			0	Do not perform diagnostics of connected cameras
			1	Perform diagnostics of connected cameras.
13	RESERVED	U8		Reserved
14	RX_TM	U16		Current value of internal variable, that watches the timeout for reception of RxIPM frame.
16	CAMS	U32		Resulting bit-array of ping to individual cameras: 0 – camera is not tested or does not respond 1 – camera detected.
20	CAMS_MASK	U32		Tested camera bit-array: 0 – camera is not tested 1 – camera is tested
24	FIRMWARE_ MAJOR	U8		Firmware version (major).
25	FIRMWARE_ MINOR	U8		Firmware version (minor).
26	FIRMWARE_ REVISION	U16		Firmware revision
28	FSG_TOTAL	U32		Total number of changes to the status code supervisory processor (see FSG_LATEST).
32	FSG_ERRORS	U32		Number of changes in status code supervisory CPU for error code – (see FSG_LATEST) FSG_ERRORS value increase during changing value in status code from 0x00 to any error code or transition from error code to another error code
36	FSG_LATENCY	U16		Delay of frame [ms]
38	FSG_VERSION_ MAJOR	U8		Supervisory processor application version (major)
39	FSG_VERSION_ MINOR	U8		Supervisory processor application version (minor)
40	FSG_LATEST	U8		Status code (hex): 0x00 – normal operation, no error 0x41 – CRC error metadata of frame 0x42 – parity error metadata of frame 0x43 – toggle error metadata of frame 0x44 – identifier error metadata of

				frame 0x45 – over limit of frame delay 0x46 – check off, performs self test 0x47 – internal error of supervisory processor
41	RESERVE1	U8		Reserved for future use (should be ignored).
42	RESERVE2	U8		Reserved for future use (should be ignored).
43	RESERVE3	U8		Reserved for future use (should be ignored).

RX_TM If the value is equal to zero, default scene is set.

CAMS The bit-array, which indicates connecting of cameras. If the relevant bit of CAMS_MASK is set, then on related bit of CAMS item is present the result of testing of connecting the camera.

CAMS_MASK Tested camera bit-array. Value is assembled by IPM in accordance with configuration file. For each defined stream that corresponds to particular camera (i.e. not the multi-stream), one bit of CAMS_MASK value is set to 1. Position of this bit in sequence is given by i-1 expression, where ‘i’ is a stream numerical identifier.

In our example with three streams mentioned above, the CAMS_MASK field will have a value equal to 0x00000003, i.e. the lowest two bits, which corresponds to streams number 1 and 2 are set to log. 1. Stream 3 is multi-view, therefore the third bit (as well as all remaining bits) is set to log. 0. The CAMS_MASK value can be used by CU as fast detection of camera drop-out. If the equation (CAMS&CAMS_MASK)==CAMS_MASK is true, then all cameras are on-line. Otherwise, at least one camera drop-out occurred.

FSG_xxx The fields with prefix FSG_ are used for supervisory processor if it is used in the IPM type. See the appropriate documentation for IPM type or project. In other cases the fields contain zeros and have to be ignored.

5. CU-RU application profile

Communication type	PARCEL
Transmission period from CU	Depends on implementation
Transmission period from RU	1 s
CU receive port	55001
CU transmission port	Depends on implementation
RU receive port	55001
RU transmission port	Depends on implementation

5.1. TxCU-RxRU Frame

This frame is transmitted by CU and received by RU.

Ofs	Item	Type	Value	Meaning
0	FLG	U16	0x0000	Frame type
2	LEN	U16	18	Payload length in bytes
4	ID	U16	0x0702	TxCU-RxRU frame type identifier
6	SEQ	U16		Ignored.
8	LIFETIME	U8	0 to 255	Incrementing counter, sign of CU activity.
9	CMD	U8		Bit-coded report:
		bit#0	1	SOS – sos event activation.
		bit#1 to 7		Reserved
10	VEHICLE	U32		Vehicle identification
14	GPS_ LATITUDE	I32	-180 /180	Latitude in I32 format.
18	GPS_ LONGITUTE	I32	-180 /180	Longitude in I32 format.
22	TIME	U32		Unix time format (number of seconds elapsed since 1970-01-01 midnight)

GPS_xxx When both fields are zero, the GPS value is considered to be invalid. Recording Unit RU does not interpret the GPS location, it only saves information. Therefore, the format is meaningless from RU point of view. An interpretation takes place till in ACASYS Studio program, where the recorded data are processed.
Initial format corresponds to I32 domain (32-bit integer with sign) on <-180, +180> degree range. It means, that range <-2 147 483 648, 2 147 483 647> corresponds to <-180, +180> degree.

Conversion of one arc second to number 1000 is recommended. Then, calculations with 0.001 arc second precision can be performed in integer arithmetic. Subsequently, the <-180, +180> arc degree range corresponds to <-648 000 000, 648 000 000> numerical range.

TIME RU accepts new value of TIME if

- TIME is not zero
- Last synchronization was at least SYNC_PROTECT_PERIOD ago

Rejecting of time synchronization is not signalised. The reason for such solution is to eliminate RU index problems when CU is sending time synchronization variation due to various reason including errors.

SYNC_PROTECT_PERIOD
After power up of the RU the first synchronization is always accepted. Then the synchronization protection period is valid and all time synchronization is rejected until this period elapsed. The default value of protection period is 8 hours. Other value can be set in a configuration (config.setSyncProtectionSeconds (4*3600)).

5.2. TxRU-RxCU Frame

This frame is transmitted by RU and received by CU.

Ofs	Item	Type	Value	Meaning
0	FLG	U16	0x0000	Frame type
2	LEN	U16	24	Payload length in bytes
4	ID	U16	0x0703	TxRU-RxCU frame type identifier
6	SEQ	U16		Ignored.
8	LIFETIME	U8	0 to 255	Incrementing counter, indication of IPM activity.
9	STATE	U8		Bit-coded report.
		bit#0	1	SOS event activation.
		bit#1	0	Recording is ON
			1	Recording is OFF due to CU request.
		bit#2 to 7		Reserved
10	ERROR	U8		Indication of RU internal error.
11	RESERVED	U8		Reserved for future use.
12	CAMS	U32		Individual camera record bit-array. 0 – recording is OFF 1 – recording is ON
16	CAMS_MASK	U32		Connected camera bit-array. 0 – camera is not connected 1 – camera is connected
22	TIME	U32		Actual unit time in Unix time format (number of seconds elapsed since 1970-01-01 midnight)
26	IS_COUNTER	U32		Counter of reports from IS.
28	FIRMWARE_ MAJOR	U8		Firmware version (major).
29	FIRMWARE_ MINOR	U8		Firmware version (minor).
30	FIRMWARE_ REVISION	U16		Firmware revision

6. IS-RU application profile

Communication type	PARCEL
Transmission period from IS	Depends on implementation
Transmission period from RU	1 s
IS receive port	Not used.
IS transmission port	Depends on implementation
RU receive port	55002
RU transmission port	Not used.

6.1. TxIS-RxRU Frame

This frame is transmitted by IS and received by RU. Received data are saved on disk in metadata form. Metadata can be used when working with records in ACASYS Studio viewer.

Ofs	Item	Type	Value	Meaning
0	FLG	U16	0x0000	Frame type
2	LEN	U16	2 + sizeof(IS_MSG)	Payload length in bytes
4	ID	U16	0x0704	TxCU-RxRU frame type identifier
6	SEQ	U16		Ignored
8	LIFETIME	U8	0 to 255	Incrementing counter, indication of CU activity.
9	MSG_TYPE	U8		Determines the IS_MSG form.
10	IS_MSG	CSTR		C-string

LEN Payload length is variable and depends on size of IS_MSG. E.g.: Size of IS_MSG="Test!" is 6 Bytes (zero escape included). Payload length in bytes is 2 + 6 = 8.

Particular form of IS_MSG string is defined by used information system.

IS_MSG==0 Format of IS_MSG for MSG_TYPE==0 is as follows:

IS_MSG consists of 6 items, separated by semicolon. The ‘semicolon’ character itself must not appear in any item.

Here are the items

LINEID	Line number.
DIR	“0” backward ride, “1” forward ride.
STNID	Current station numerical identifier.
STNAME	Current station name in UTF-8 code.
GPGGA	GPS coordinates in GPGGA sentence format

Example

```
9;0;;Kobylisy;$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46
.9,M,,*47
```

Line No. 9, backward ride, none station ID, station name Kobylisy, GPS location in GPGGA sentence format. The entire string is terminated by binary zero.

6.2. TxRU-RxIS Frame

RU does not transmit to IS.